

be placed after photosynthesis, and after the account of parasites and saprophytes; here it is noticeable that *Lathræa* is placed amongst carnivorous plants, without any mention of Groom's work. But few practical experiments are suggested, and it would be easy to improve the apparatus depicted in figs. 204, 206, 208, and 219. Finally, the last chapter, in which irritability is discussed, is headed "Movements of Plants," which quite ignores the phenomena of stimulus, and the stimulating source.

In the introduction, the authors state that they have been impressed with the need of a work which should contain all the information which is necessary for certain examinations. On the contrary, the present tendency, and there is much to be said in favour of it, is to bring out smaller books, written by specialists, which deal only with one branch of the subject.

*Traité de Chimie physique, Les Principes.* By Jean Perrin. Pp. xvi + 300. (Paris: Gauthier-Villars, 1903.)

THIS volume deals with the elements of dynamics, the thermodynamical potential, the phase law and other allied subjects of which a knowledge is indispensable to the modern chemist. The treatment is non-mathematical, but the author indulges in a good many discussions of a philosophical character. In defining the scope and aim of physical chemistry, he refers to the old style of thinking, according to which physics was the science of reversible phenomena, and chemistry the science of irreversible phenomena. The notion of *force* is defined by means of the extension of a stretched elastic string or wire. Why should not this treatment be adopted in books where relations involving mass and acceleration do not play a prominent part? We notice, as a useful feature, that Lord Kelvin's definition of absolute temperature is dealt with at some length. In the preface the author rightly directs attention to the desirability of abandoning such misleading notions as that of absolute in contradistinction to relative velocity, the statement that "heat cannot pass from a cold to a hot body," which is like speaking of an apple passing from one hand to the other, and the prevalent confusion of language in speaking of ideas involving force and energy.

*The Arithmetic of Elementary Physics and Chemistry.* By H. M. Timpany. Pp. 74. (London: Blackie and Son, Ltd., 1903.) Price 1s.

THIS collection of numerical exercises is very limited in its scope. It is composed of four sections; one includes problems on relative densities, another is devoted to examples on moments and centres of gravity, a third is concerned with the conversion of thermometric scales and with specific and latent heats, while the last deals with the calculation of the weights and volumes of the substances taking part in chemical reactions. Typical examples are worked out for the guidance of the student.

*Gisements minéraux. Stratigraphie et Composition.* By François Miron. Pp. 157. (Paris: Gauthier-Villars and Masson et Cie, n.d.)

M. MIRON here provides geologists and others with a compact account of numerous non-metalliferous mineral deposits which are useful in numerous branches of technology. A previous volume in the series known as the "Encyclopédie scientifique des Aide-Mémoire," to which the present book also belongs, dealt with those minerals in which the metallurgist is particularly interested, and attention is here chiefly directed to the natural sources of sulphur, nitrates, phosphates, borates, compounds of the alkali and alkaline earth metals, and other minerals.

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## LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

### Human Science and Education.

THERE surely never was a time when there was more need for consideration of the root-principles of higher education. It is generally allowed that we in England are behindhand in the matter, that we have allowed the Germans and Americans to have the start of us. And awaking to this conviction we have a difficulty in seeing in what direction we should move in an attempt to recover our lost ground.

I accede with pleasure to a suggestion of the Editor of NATURE that I should endeavour to lay before his readers some of my views as to the direction in which those studies which have man for their subject should move. At first sight it might seem that the present place is inappropriate for a paper of this kind. Yet it is among the students of nature that my contentions as to the study of man are perhaps most likely to find support.

What I plead for is that the two great branches of knowledge, the science of nature and the science of man, should be brought nearer together, that it should be recognised how much they have in common, and that the reasonable votaries of both should make common cause against the same enemies.

The enemy in higher education of the science of nature is the technical spirit, which will not take a wide outlook, which ties all investigation down to narrow points of practice, which does not see that breadth of study and imaginative insight are necessary in our schools of science if we would produce men of real efficacy for the work of the world and not mere technical experts. The enemy of the science of man is the spirit of convention, which is dominated by rhetoric and commonplace, which has no ambition to see the facts of human nature and of history as they really are, but interprets them by tradition by self-interest, by sentiment. And between these two enemies of the children of the light there springs up a natural alliance. The man who has received a narrow technical training may be a good linguist or the like, but is not likely to appreciate a wide humanistic culture. The man who has received a merely conventional literary education may master technical details, but will scarcely understand how the steady growth of science, of ordered knowledge, has changed our whole way of regarding life, religion or society. The two enemies will combine when they can to keep education at its present level, and to ridicule all attempts to provide a really scientific training in universities and schools.

It is scarcely necessary to say much in these days as to the importance of a thorough organisation of the study of nature and natural forces in our colleges. There has been in this matter extraordinary progress in the last thirty years. At any rate it would be an impertinence for me, who have never been trained in any branch of natural science, to dwell on this matter. But while natural studies have moved forward rapidly, those which concern man have in our universities scarcely moved. The course in humanity, and in modern history, is at Oxford almost exactly what it was thirty years ago. Cambridge is less averse to change than Oxford, and has been more mobile; yet it may be doubted whether human studies have imbibed much more of the modern spirit in Cambridge than at Oxford. In the new universities which are springing up on all sides, generally speaking the side of natural science is more or less well developed with teachers and apparatus, but in the matter of history, psychology, archaeology and the like they are much to seek. In the case of the new University of London, one sees the germs of better things. Several of the schemes of study there arranged look well on paper. Only funds are needed to set the machine in motion. In London there are great institutions, like the Record Office and the British Museum, which are in the nature of things obliged to be scientific, and one hears great things of the London School of Economics.

I think the readers of NATURE will admit that the slow-

ness and incompleteness with which reorganisation is going on in the studies concerned with man is an undesirable, even a dangerous, fact. The disparity between the two halves of human knowledge has grown so great that there is a fear that almost all young men of original or inventive mind will turn to the study of material nature. It would be foolish to make any comparison between the importance of the knowledge of man's surroundings and the knowledge of his nature, his works, and his history. Both are beyond value. But if the two halves of the human brain, so to speak, work on different plans, what will become of the unity of man himself?

A reason why the votaries of natural science should have some sympathy with those who are endeavouring to remodel humanist studies is that it is from the natural sciences that methods and ideas have flowed into those relating to man. The ideas of continuity, of adaptation to environment, of evolution, were transplanted into historic studies from those of biology, and it was soon found that they flourished almost as well, and bore almost as much fruit, in the new field as in the old. But whereas the highly trained and scientific worker in history, psychology, archaeology, and kindred studies is quite alive to the use of the new scientific methods, they have as yet only partially affected education in these subjects, even in our universities. The books used by the students are changed in character, but not the ways of working. Undergraduates are not thoroughly taught the principles of weighing evidence, they are not accustomed to work on the comparative method, they do not acquire historic imagination. They have not learned to judge by evidence rather than by authority, nor rigidly to distinguish degrees of probability.

Of course, education is not, and cannot be, only scientific. To everyone's education there should be other sides. There should be a religious side, in some ways the most important of all. There should be an artistic side. Every boy and every girl should be taught to draw or to play some instrument, and to appreciate good work done in the art which is thus practised. And every student should be taught to use the English language to some purpose, and to appreciate what has been best written in that language, and in one or two other languages. But at present I am not speaking of religious, of artistic, or of literary education, but of scientific education, of the direct training of the faculties for dealing with the facts of the world; and it is my contention that this scientific side of education has been comparatively neglected in the case of those who have not taken up some branch of physical science. In fact, so completely has the really scientific character of such studies as history and archaeology and economics and the like been, at least in this country, overlooked that when we hear of a man studying science it is at once assumed that he is giving his attention to the facts of the natural rather than of the human world. But the word science has not and cannot rightly have any meaning but "ordered knowledge." Whatever can be surely known is matter of science.

But I must come to the practical question of the organisation of study, and especially of university study. Knowledge of the physical world has so greatly grown by two things, the improvement of method and the organisation of research. Improved methods of investigation in the study of man and of history have fairly come in: they are scarcely yet fully recognised in schools and universities, but the best authorities in the various branches of the subject are acquainted with them. What is most needed is a new organisation of research.

At present in our universities the spread of better methods in the human studies has principally effected this, that the student works on better text-books. This in itself is something, but not very much. Compare, for example, such a subject as geology. Would it be regarded as sufficient if the students of geology read books in which the latest and most approved views are expressed? Surely not; until the student has grubbed for himself in the chalk pit and the cliff, and learned in museums to recognise the substances belonging to various strata of the earth, he has done nothing worth doing. He must not take results ready made, but must work for himself; see for himself, learn the value of evidence and the touch of fact. I venture to think that the case is the same in human studies. Here also it is of little use to accept the best results, unless the student grasps

the grounds on which they are reached. Here also he must for himself work on the data, see why one view is more probable than another, map out the exact state of the evidence.

Our remedy is to adopt in the human sciences organisation and methods of study which have triumphed in the natural sciences. In every college and university there should be, beside the laboratory of the chemist and the dissecting room of the physiologist, work-rooms for the students of man. As regards psychology and anthropology, which are two foundation stones of the arch, this is already conceded. Specimens and apparatus are there acknowledged to be necessary. The same necessity exists as regards other branches of human study. Work-rooms are needed in which the student should be, so far as possible, brought into contact with evidence. All the important books, dictionaries and the like should, of course, be there. And besides, the authorities for the books should be so far as possible put together, facsimiles of documents and of inscriptions, maps, chronicles, coins, seals, and the like. In the economic section every kind of statistics should be at hand. In the department of ancient history there should be casts of inscriptions, photographs of sites, facsimiles of manuscripts, casts of statues and of coins. Even when such objects are not direct authorities for the points of which the student is in search, they form his mind by bringing him into contact with fact and evidence, and they greatly stimulate his imagination by placing him in presence of some of the surroundings of history. The result of work of this kind would be a change of outlook and of method, the substitution of investigation for theory, of science for fancy. It would prepare the student for wider work in the actual world, for which, of course, it would be no substitute but a *propaedeutic*.

Those who teach and organise natural studies are fully alive to the great demands made by the changed state of the world, and are demanding endowment with energy and persistency. They are quite right. But the teachers of human studies are more inert and less keenly alive to the need of expansion. But science, ordered knowledge, is, in spite of all divisions, one, and it will be a great misfortune for the country if in the extension and re-endowment of our university system the necessity of thorough and elaborate investigation of man in all his aspects, his history and his works, falls into the background.

Oxford, October.

P. GARDNER.

#### Uniformity in Scientific Literature.

In 1894 a committee was appointed by the British Association to inquire into the question of uniformity in the size of the pages of proceedings, transactions, and scientific journals in which original papers are published. The appearance of a number of *Proceedings* of the London Mathematical Society of a different size from its predecessors, in accordance with an announcement circulated as recently as the end of August, suggests that it may be desirable to direct attention to the report of this committee (Brit. Ass. Rep., 1895, p. 77).

In this country all the more important octavo journals in question are printed on either medium or demy paper; as examples we may cite the Royal Society's *Proceedings*, the *Philosophical Magazine*, the *Proceedings of the Physical Society*, &c. A considerable number of foreign journals (e.g. Wiedemann's *Annalen*) are of practically the same size. The difference between medium and demy octavo is too small to cause any inconvenience either in placing the volumes together on a shelf or in binding together reprints of papers. In the case of certain American and Italian journals a somewhat larger sized page has been adopted, but the difference is entirely in the margin, the printed portion being in some cases smaller even than in our demy octavo journals. This allows of reprints being cut down for binding with others from the *Philosophical Magazine* or British Association Report, and still leaving plenty of margin. Where papers are too long to be published in octavo form, medium and demy quarto are the most prevalent sizes. Here again there is not much to choose between the two, and, as in the case of octavo, the committee decided to recommend the demy size as a standard. The most inconvenient pamphlets to deal with are those in which the paper is too small for binding up